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**Schmiegelow, Andreas; Andersen, Maj Munch**

*Published in:*
EU-SPRI Conference Lund 2016

*Publication date:*
2016

*Document Version*
Publisher's PDF, also known as Version of record

# Absorptive Capacity and Industrial Symbiosis – Experiences from the Danish Green Industrial Symbiosis SME Program 2013-2015

**Andreas Schmiegelow*** and Maj Munch Andersen
(Technical University of Denmark)
*anschm@dtu.dk

**KEYWORDS: Industrial symbiosis, Dynamic capabilities, Organizational learning, Absorptive capacity, SME**

Research question, hypothesis and relevance:
Industrial Symbiosis (henceforward IS) may be understood as the mutually advantageous utilization of residues and by-products between traditionally separate industrial entities (M. R. Chertow, 2000: 313). Despite not being a new phenomenon (M. Chertow & Park, 2016), IS has recently risen to the vanguard of political appraisal (Laybourn & Lombardi, 2012; Wang, Deutz, & Gibbs, 2015). With appeal to the comforting prosaic idea that one company's 'trash' could in fact be another one's 'treasure', IS is endorsed as a tool for systemic innovation vital for green growth (OECD 2010 in Lombardi & Laybourn, 2012: 28). A game-changer for sustainable development (WWF 2010 in Laybourn & Lombardi, 2012: 10) with the ability to put circular economy thinking into practice and promote recirculation of industrial residues and by-products and effectively optimize companies' resource consumption (EC, 2011, 2015).

By analyses of data collected among participants in the recently ended Danish Green Industrial Symbiosis SME Program (the 'GIS-program') this paper aims to provide some nuances to the apparent sanguine political belief in IS as a ubiquitously applicable engine for green growth and eco-innovation.

Specifically, this paper dives into the question of why an evaluation report conducted by the Danish Business Authority as the GIS-program ended, showed that only approximately 10 pct. of the 174 IS opportunities found during the program was implemented. A result that ostensibly stands in opposition to the general appraisal of IS, as well as to conclusions drawn from similar 'facilitated' IS policy initiatives (Laybourn & Morrissey, 2009; Paquin & Howard-Grenville, 2012).

The literature on IS has evolved significantly in recent years highlighting several factors that may affect the formation of IS. These include e.g. environmental and economic benefits (M. R. Chertow, 2007; Van Berkel, 2010); incentivizing policies and regulation (Salmi, Hukkinen, Heino, Pajunen, & Wierink, 2012); and social embeddedness among IS partners (Ashton & Bain, 2012).
One line of research considers the epistemological component in IS, because as argued, for IS to succeed large amounts of data and knowledge need be collected, processes and shared between IS partners (Davis, Nikolic, & Dijkema, 2010). Knowledge barriers for IS include companies' lack of knowledge on waste utilization opportunities (M. R. Chertow, 2007), inadequate knowledge about waste stream compositions to evaluate IS opportunities (Allen, 2004) and lack of appropriate ICT-tools to ease transfer of knowledge between potential IS partners (Grant, Seager, Massard, & Nies, 2010; Trokanas, Cecelja, & Raafat, 2014). However, despite general appreciation of the epistemological component in IS, little attention has been given to factors that influence the actual attainment of knowledge on IS opportunities in companies and the concomitant commercial application of this knowledge. In that sense, the epistemological component in IS has mostly been treated an issue of information deficit that need to be corrected for IS to proliferate.

We, however, hypothesize, based on insights from the literature on dynamic capabilities and organizational learning, that part of the answer to the issue of the epistemological shortfall in IS resides elsewhere. We propose that the reason why IS does indeed not proliferate ubiquitously is not only because the knowledge needed to make it so is unavailable, but also because companies, and especially SMEs, lack the capacity to attain and utilize it. SMEs' having such lack is not a novel insight (Gray, 2006; Muscio, 2007), however, one that hasn't been given much attention in the context of IS (cf. Boons & Spekkink, 2012). In this paper, we will thus attempt to fill what we see as an important gap in the IS literature and, based on data from the GIS-program, test the extent to which there is a connection between companies' capacity to attain and utilize knowledge and the implementation of IS and if so, how this connection might be understood. With the increased attention to IS

among policy makers, we regard a filling of this gap to be a relevant contribution, not least in regard to the development of a sustainable bio-economy in which IS may be considered a central component (see e.g. Lopes, 2015)

## Theoretical framework

When considering companies' abilities to attain and utilize knowledge, 'absorptive capacity' stands as a central concept, and since Cohen & Levinthal defined it as 'the firm's ability to identify, assimilate and exploit knowledge from the environment' (Wesley M Cohen & Levinthal, 1989:569-70) it has gained widespread recognition (see Van Den Bosch, Van Wijk, & Volberda, 2003). This is not least due to its ability to incorporate dynamic capabilities (i.e. organizations' ability to adapt) (Teece, Pisano, & Shuen, 1997) and organizational learning (i.e. organizations' encoding, storing, and retrieving of knowledge) (Levitt & March, 1988) perspectives (cf. Easterby-Smith, Graca, Antonacopoulou, & Ferdinand, 2005).

Since Cohen & Levinthal's initial definition, several modifications have evolved one of which is Zahra & George's (2002), who on basis of the contention that companies need to transfigure external knowledge before they can utilize it, expand Cohen & and Levinthal's three components of absorptive capacity (identify, assimilate, exploit) to four (acquire, assimilate, transform, exploit). As the transformation or modelling of knowledge may be considered particular pivotal in the case of IS (Trokanas, Cecelja, & Raafat, 2014), we will in this paper follow Zahra & George's (2002) conception.

Despite being a pervasively applied concept (Lane, Salk, & Lyles, 2001), organizations absorptive capacity has mostly been measured by the use of R&D proxies (patents, expenditures, personnel, etc.) (Flatten, Engelen, Zahra, & Brettel, 2011). Such approach, however, ignores the multi-dimensionality of the construct (acquire, assimilate, transform, exploit) (Flatten et al., 2011) and is less relevant in the context of SME's where formal R&D activities are often limited (Muscio, 2007), implicitly rather than explicitly conveyed (Lundvall & Johnson, 1994) and innovation happens in a DUI- rather than STI-mode (Jensen, Johnson, Lorenz, & Lundvall, 2007).

Accordingly, in order to measure the absorptive capacity of participants in the GIS-program we need a measure that considers the multiple dimensions of such capacity, however, is applicable in a SME setting. Therefore, we apply Flatten et al.'s (2001) literature-based item-pool framework that considers all components in Zahra & George's (2002) absorptive capacity conception, however, modify it so that it is sensitive to SMEs' particular organizational setup thus leave out or alter a number of items in the framework that assume a hierarchical organizational structure with various management levels.

## Methdology and expected outcomes

The paper's data sample is gathered from a database developed by the Danish Business Authority during the GIS-program as well as collected among companies participating in the program through a survey using Likert-scales on the various selected/altered items from Flatten et al.'s framework (2011). Other relevant data that may explain the lack of implementation of IS is gathered as well (see e.g. above mentioned factors) through semi-structured interviews. This data is important in order to account for non-absorptive capacity factors that may have influenced the implementation of IS. Here it is worth remarking that one of the authors has been heavily involved in the GIS-program, thus have a unique access to the participating companies and inside information.

The expected outcome of the paper is a deeper theoretical and empirical clarification of the IS concept and its epistemological component. Empirically, we expect to conclude that there is a significant connection between absorptive capacity and IS, so that the companies where IS has been implemented show a higher level of absorptive capacity compared to those where it has not. As mentioned, since IS may be considered a central component in a bio-economy (see e.g. Lopes, 2015) we consider these outcomes to be highly relevant in a bio-economy policy perspective.

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